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British Journal of Anæsthesia

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THE PRACTICE OF ANÆSTHESIA IN FRANCE.

By Dr. Henry Bourbon, Paris.

1. *General Considerations.*

In France anæsthesia is not recognised as a speciality in the hands of qualified practitioners. Surgeons select their assistants as they please from past and present pupils, or from suitable colleagues. In large centres where hospitals are numerous and well-equipped, students are taught, as routine, the various methods of anæsthesia under the supervision of the " chief " or his assistants. In consequence, there are few medical men who do not feel capable of anæsthetising a patient by some method.

For the operations in private practice hospital surgeons seek either an intern or a colleague who shall be habitually installed in that post. Indeed, many practitioners have thus been able to specialise. When a surgeon has adopted an anæsthetist in whom he has confidence, he employs him exclusively, so that the two live in close association as regards habits and views. On the other hand, the anæsthetist can hardly extend his clientele, which is, of necessity, limited to the operators of one block, or to a team of operators in one clinic.

It is then always the surgeon who decides everything, and the initiative of the anæsthetist is restricted to a certain degree, but the good results obtained show that this is only of secondary importance. The establishment of teachers of anæsthesia in hospitals would be, however, desirable, and the resulting co-ordination of existing conditions would lighten the care of the chiefs and of their assistants.

At a recent Congress of Surgery, Dr. Lardennois brought up these questions. Does this mean that the anæsthetic should be left in the background and neglected? Far from it, because it always is the great anxiety for the surgeon; but the growing development of surgery, with its ever-spreading field of activity, brings forth new methods of operation which call for an increasingly elastic adaptation of anæsthetic methods.

The most important progress to notice is the place taken by, so to speak, half measures, by which local analgesia has acquired the right to be cited side by side with general anæsthesia, in conjunction with which it is used, even for operations which hitherto seem to belong exclusively to the domain of the latter.

In consequence, there is a large selection and operators have an increased choice according to the cases, circumstances, and moral and physical condition of the patient. There seems to be a tendency to let local and regional analgesia supplant general anæsthesia.

The multiplicity of methods makes it exceptional that one or the other cannot be employed even for very trivial operations. Let us note that the convenience of ether is one of the important factors of this boon.

A.—ANÆSTHETICS. *Methods which suppress consciousness.*

In a great majority of cases for severe operations preference is given to chloroform, and many are the doctors who know how to give it, either by means of a towel, which one can get at any time or in any place, or with apparatus which has been in vogue for some time. It is believed that among other advantages, by reason of its vaso-constrictor properties, it " conserves the blood " and that it, more than any other agent, gives " abdominal silence." It has strong adversaries, it is true, but it is considered that they are misled by theoretical objections. It is easy to obtain very good results with other agents, skilfully used, but the indication is to keep chloroform for people of old age, and those whose respiratory organs do not enjoy perfect integrity.

The question of selecting a method of anæsthesia suitable for the circumstances as regards sequelæ, and as regards the

patient's condition, was the subject of a communication by Monsieur Lambret and Monsieur Lardennois at a recent Surgical Congress.

The excellent apparatus of Dr. Ricard has made the administration of chloroform easier and safer, and other important instruments have taken a prominent position. Ether, which has never been abandoned by the Lyons School of Surgeons, has come into favour again after prolonged neglect.

To begin with, by employing Julliard's mask, some anæsthetists obtain excellent narcosis for major intra-peritoneal operations, but it is more specially owing to the apparatus of Dr. Ombredanne that its use has grown in favour.

Besides the use of ether by inhalations attention has been paid to the advantages offered by insufflation of ether vapour into the respiratory tract. A choice of methods exists, the only delicate one being intubation of the larynx.

Besides this method, the importance of which is well-known, many surgeons have, at different times, conceived, and put into practice, the idea of introducing ether oil, or warm ether vapour into the colon to produce general anæsthesia. This practice, when properly conducted, has, for some time, given encouraging results, and its employment seems to deserve to become general, considering that, just as with insufflation, it allows of the patient being placed in any position, an important factor in operations on the chest, and one which obviates the necessity for the complicated arrangements of Sauerbruch and Brauer.

Ethyl chloride, which for some time was thought to be applicable for short anæsthesias only, gives nowadays, in expert hands, results comparable with those of its predecessors, at least, if muscular relaxation is not particularly essential, and provided the operation does not exceed 30—40 minutes in duration. Moreover, it has the advantage that, if necessary, narcosis can be continued by another agent, a practice which is routined in some centres. It has displaced ethyl bromide, which was in favour during the latter part of last century, when it attracted the attention of many surgeons everywhere. With us, Dr. Lucas Championniere, resuming experiments

which had been tried on all sides, was struck, as was also Dr. Poitou-Duplessis, by the ease with which its action could be continued by another anæsthetic, such as chloroform. But the action, though very short, quickly becomes toxic. There is, then, everything to be gained in a similar process, and in 1892 Dr. Hartmann and I endeavoured to popularise it.

Dr. Calmette, on the other hand, had previously introduced ethyl bromide in laryngological practice for adenoid operations, and Dr. Sauvez had used it in dentistry; but, some years later, ethyl chloride which, although well known, had only been used as an analgesic spray, when produced in a convenient form, and in a purer condition, was tried for inhalation. Soon its feeble toxicity, and the advantages which are now well-known, caused it to take the place of ethyl bromide. It was found to be applicable, not only for short operations, but for long ones. Its action could easily be continued by some other anæsthetic and such practice became the rule in many surgical centres. A number of practitioners use it alone, or in conjunction with ether or chloroform, or both, then varying the properties as indicated.

This brings us to the subject of anæsthetic mixtures previously prepared. Of those which have been used, the mixture of Schleich seems alone to have retained favour, and to have enjoyed unmitigated success. Dr. Polaillon and Dr. Lejars have used it for some time. Professor J. L. Faure has become an advocate of it, recognising its great safety as well as its freedom from post-anæsthetic vomiting. It is the one method which is suitable in the greatest variety of circumstances and in all ages, and its use gives great security.

It is a great pity that nitrous oxide grows in favour so slowly with us. Perhaps the want of anæsthetic specialists is the cause; also, perhaps, this fact, that the chemical industry has to be re-established for its production, which has not yet been attempted in the hospitals.

Possibly the apparent complication has frightened some surgeons, their requirements having been satisfied by simpler methods. But this excellent agent, capable of such good service, cannot, as a matter of fact, be entrusted to inexperienced hands. We should have in this an inestimable collaborator, completing the series of methods which we

already possess to aid us in meeting practically every difficulty. The number of weapons to employ against pain can never be too great, and one must hope that nitrous oxide will come into its proper place.

The qualities of this gas have been known in France for a long time, and important work has been done to try and introduce it in major surgery. We recall specially that of Paul Bert, and a special apparatus constructed on his lines by Pean and L. Labbe. Very complicated contrivances were abandoned, and it is in other directions that we must look for good results in nitrous oxide. On the other hand, many dentists since Duchene have never ceased to use it alone, or in conjunction with chloroform or ether, and since the introduction of ingenious apparatuses it has a place in many surgeries. It is obvious that the number of its advocates is increasing steadily. At the recent Congress of Surgery Dr. Lardennois sang its praises. Some doctors, it must be understood, have devoted themselves to its study. Much wonderful apparatus employed here during the war by English and American specialists was left with us, and is in use in many centres where gas is obtainable. More simple apparatuses have been constructed, which, in expert hands, give very good results in suitable cases. Moreover, in 1913, Dr. Martel undertook the installation of an operating theatre similar to that of Pean, equipping it with the advantages of modern inventions. His good work was, unfortunately, stopped by the war, but a trend of ideas had, undoubtedly, been established.

It may be that the apparent neglect into which so valuable a surgical adjuvant has fallen, was due to the facilities which local analgesia offers, causing the latter to be used by so many surgeons for almost every emergency. Gas has been accused of unduly raising the blood pressure. Chloralose was, at one time, tried as a general anæsthetic in the form of intravenous injection, but was found to be little suitable for human surgery. It is now used in physiological laboratories for anæsthesia in animals, because, whereas hypnotic action is marked, it has practically no effect on vital functions.

Scopolamine seemed, at the beginning of the century, to be likely to take a place among anæsthetics of choice. Professor Terrier especially experimented with it, but he soon

hesitated, owing to dangers which followed its employment in doses sufficiently large for operating. On the other hand, it is common knowledge how popular it has become as an aid to anæsthetics. Used as recommended by Dr. Walther and Dr. Jalaguier in doses not exceeding a half to two-thirds milligrammes injected in two instalments one hour and a half an hour respectively before the induction of narcosis, which is thereby rendered smooth, the amount of general anæsthetic necessary being thus greatly reduced. Generally scopolamine is given with about one centigramme of morphia. Some practitioners have tried the addition of heroin to the mixture, and Professor Lacene used pantopon, an extract of opium. The effect of this practice is, from all points of view, to be recommended, because the patients enjoy a well-marked calm, and the sleepy condition in which they are placed before the induction saves them from anxiety, and complete awakening occurs only some hours after operation, the subsequent pain being thus rendered more tolerable. In some cases the patient has no memory of the day of operation.

In obstetrics the use of anæsthetics is as general as circumstances permit, and it is to chloroform, which in small doses is believed to be safe, that one commonly looks for best results. Experiments have recently been made with somnifene, by intravenous injection. This product is a urea-derivative and has been employed in general surgery, but nothing definite can be said about it. It is only in passing that we need refer to the fact that trials are being made with ethylene and acetylene anæsthetics.

B.—Analgesics. *Methods conserving consciousness.*

Methods of local analgesia are now generally known, and in all directions they are the subject of interesting communications, owing to the skill with which surgeons employ them in the place of general anæsthetics.

Since the time (1889) when Professor Reclus and his pupils drew attention to the immense service these drugs were capable of rendering, a definite school was established.

Cocaine, which requires care in its use, without which satisfaction cannot be obtained, has a toxicity which frightens many surgeons. Substitutes, such as eucaine and stovaine

have been introduced, and encourage the extension of this method.

At present it is almost entirely on novocaine that one depends, and rightly so. An increasing number of operators tend to give it preference over general anæsthetics, which some employ only in very special cases. Time will show the value of practices which seem somewhat prejudiced.

Moreover, local analgesia can be very conveniently combined with anæsthetics. Especially deserving of notice is the scientific application of Professor Crile, whose method of anoci-association have a world-wide fame, and have attracted the attention of many surgeons in France.

In the case of patients in a state of reduced resistance, it is well to begin operation with analgesia, keeping anæsthesia for the more painful manipulations. In this case it is ethyl chloride which is favoured. However, chloroform does very well when given in minimum doses.

Spinal analgesia, which has much to be said in its favour, has many enemies. Nevertheless, it is used very widely, but, as a matter of fact, operators look for methods of proved value which seem likely to offer the greater service. There are methods of splanchnic analgesia to the study of which Dr. Walther, Jun., has devoted himself, and which, combined with local infiltration allows very complicated operations to be carried out, sometimes without shock or toxicity.

Analgesics for the trunk are employed, but they also are very difficult in practice. These methods have been almost entirely confined to surgeons, but it is possible that, in the near future, anæsthetists will see their field of activity enlarged in this direction.

Pre- and Post-operative care of the patient.

There is nothing to say on this subject which is not already known, and doctors all over the world are interested. Old ideas have changed with the growth of knowledge in biochemistry.

Purgation before operation, which, until recently, was thought to be indispensable for disinfection of the intestine, is now kept only for rare and particular cases, in which the operation is not intended to be upon the peritoneal cavity, because it can only congest the digestive apparatus and reduce

the resistance of liver and kidneys. Moreover, purgatives act as dehydrators of the body, whereas indication is for hydration which is obtained by reason of drinking and of vegetarian diet. In certain subjects in addition saline and glucose are given subcutaneously or per rectum.

Eggs, meat and fat may be regarded as increasing organic acids. It is necessary to be careful with reference to disinfection of nasal, buccal and pharyngeal cavities, the sources of parotitis and sinusitis in many cases. But although the nurishment of patients about to be operated on needs care, it is important that the stomach should be emptied of food at the time. A full stomach, owing to distension with gas, impairs movements of the heart, to say nothing of reflex phenomena. There may be quite enough trouble with many patients, owing to the swallowing of air in early stages. Consequently, in some operations of urgency, the anæsthetist's attention should be directed to this point.

Besides alkaloid injections preparatory to anæsthesia some surgeons strive to support the strength of the cardiac muscles, and to combat vagus action by atropine and morphia as recommended in 1879 by Morat and Dastre.

Spartein seems to have been given up as uncertain and toxic, and strophantus has taken its place. The custom of not allowing patients to drink who so often suffer dreadfully from thirst is gradually being abandoned. To many it gives great relief to have the mouth frequently moistened with alkaline, and the use of saline injection, especially by the continuous rectal method, whenever possible, is the greatest help. The moderate administration of alkaline fluid seems to be permissible in most cases. Should vomiting occur there is something then to evacuate, and the patient does not suffer from "being sick on an empty stomach." Also it may act as a means of washing out this organ.

For the treatment of vomiting besides the taking of small pieces of ice, many medicines have been tried and found more or less unreliable. Latterly valerianate of cerium has been recommended. We may add that filling the colon with saline, with or without glucose, before the end of narcosis, with the patient in the prone position, is in vogue in many surgical centres. In this position the fluid is well retained and well borne.

ANÆSTHESIA AND THE BAD RISK PATIENT.

By G. W. Crile, M.D.,
Cleveland, Ohio.

WITH the discovery that there existed agents which would render a patient unconscious at the moment of the infliction of surgical trauma it must have appeared that the safety of surgical procedures thereafter would be limited only by anatomical possibilities. However, in spite of the establishment of the principle of asepsis and of increased refinement of technique, it soon appeared that inhalation anæsthesia in itself presented certain dangers, although the exact nature of the danger was not at first comprehended.

As soon as this was appreciated, the controversy between the advocates of different inhalation anæsthetics began and later the issue became still more complicated by the introduction of local and again of spinal anæsthesia as substitutes for inhalation anæsthesia.

For the good risk cases each surgeon could follow his own predilection with comparative impunity, but in the case of the bad risk patient he was confronted by an exceedingly serious dilemma:—Which presents the greatest danger, the interference with the internal respiration by the general anæsthetic, or the uncertainty of complete control of pain plus the certain emotional strain resulting from the use of the local anæsthetic alone or the danger from decreased blood-pressure in the case of spinal anæsthesia?

In an attempt to solve this problem we have made experimental and clinical studies of the effects of surgical trauma administered under different types of anæsthesia. This experimental study has included histological, chemical and biophysical studies of the various organs and tissues of the body, especially of the brain cells and liver cells, in the different stages of ether and of nitrous oxide anæsthesia and after trauma under local anæsthesia in order to discover the effect of the emotional factor.

The results of these studies may be briefly summarized as follows :—

ETHER ANÆSTHESIA.

Period of Excitement. In the first stage of ether anæsthesia the subject tends to struggle, the face is flushed, there is sweating, moderate or violent muscular action, rapid respiration, dilated pulse, elevated blood pressure, accelerated pulse, an increased output of adrenalin, hyperchromatism of the brain cells increased, electric conductivity of the brain cells and the temperature of the brain increased, the consumption of oxygen may be increased up to 150 per cent., of carbon dioxide up to 325 per cent. (Alexander and Cserna), the H-ion concentration of the blood is increased.

Osterhout, Overton, Meyer, Lillie and other observers have shown that ether anæsthesia in lighter doses increases the permeability of the semi-permeable membranes of cells to the passage of ions. The activity of cells is governed by the state of permeability of their membranes to ions (Lillie). This increased permeability renders the brain extremely excitable in light ether anæsthesia, and therefore it drives the organism to perform more work, as has been shown by Alexander and Cserna, by our observations of hyperchromatism, by Elliott's demonstration of diminished adrenal content, and by our demonstration of increased adrenalin output. The clinician sees striking evidence of this increased activation of the brain in the behaviour of his patient under light ether. In cases of hyperthyroidism, the increased activation of the first stage of ether anæsthesia is especially marked.

The clinical phenomena and the experimental findings lead us to suppose that ether causes a greatly increased production of electric energy, which escapes readily through the lowered resistance of the cell boundaries and of the synapses, and in consequence we may presume that heavy charges of electricity are freed from the cells, and run over the open nerve paths leading to the various muscles and glands. The muscular and glandular responses are as free from purposeful action as in a convulsion, but if the victim is held or injured during this stage then the electric action current is led over the corresponding facilitated paths and is concentrated on the muscles required for action, and other muscles become idle.

If no contact directs the current then the outflow of energy is as general as in an epileptic convulsion; there are contractions of all the muscles; increased secretion of the salivary and the mucous glands; increased sweating; and the output of adrenalin is increased.

As we have stated, if the patient is restrained or injured during the first stage of anæsthesia, then the muscles that usually respond receive all the collective electric force of the brain, and show almost supernatural power. If the anæsthetic is withdrawn at this stage, the permeability of the cell returns to the normal, the struggle ceases, the flush fades from the face, the sweating ceases and the secretion of saliva and mucous rapidly become normal, the muscles come under voluntary control and are quiet. The individual appears normal with the exception of a slight fatigue.

Stage of Even Anæsthesia. If the administration of the anæsthetic is steadily continued through the stage of excitement, or if the amount is increased, the period of struggle soon passes into a stage of complete relaxation. The face remains flushed, although less so than in the stage of excitement; the eyes are less suffused; the skin is less moist; the saliva and mucous are less abundant. The H-ion concentration of the blood increases with the increase of anæsthesia. In this stage physical injury and restraint cause no marked muscular response.

This is in accord with the findings in our electric conductivity measurements, which showed a decreased conductivity of the cerebrum in deep ether anæsthesia, as contrasted with the increased conductivity in the stage of excitement. Measurements of the temperature of the brain show that following a brief rise in the initial stage the temperature falls progressively. Moreover, as has been stated by Lillie, McClendon and others, during the stage of complete anæsthesia the permeability of the cell and synaptic membranes to the passage of ions is decreased in contrast to the increased permeability of the stage of excitement.

It seems probable that anæsthesia is due to a block in the synaptic membranes like that which is supposed to occur in sleep, the difference being that in sleep the synaptic block is at once overcome by stimuli, hence is adaptive; whereas in

anæsthesia, the block is physical and non-adaptive. For this reason stimuli do not wholly awaken the patient, but nevertheless the afferent impulses reach the brain cells and stimulate them without purpose—exhausting the brain just as if no anæsthetic had been given.

Profound Anæsthesia: Death. If the anæsthesia is pushed still further, a point of saturation is reached at which the H-ion concentration of the blood passes the neutral point. This is the fatal point, for when the anæsthetic causes actual acidity of the blood, death takes place immediately. Death, we assume, is due to the loss of difference in potential in the autonomic and sympathetic systems, as well as in the cerebro-spinal systems; hence, electric impulses cannot pass, and life ends.

The several parts of the brain differ greatly in their response to ether. It would be expected that the brain as a whole would be more markedly affected than other tissue, such, for example, as muscle, because the brain contains a greater proportion of lipoids, which are especially affected by ether. We would expect also that the order in which the different portions of the brain are affected would depend upon their relative irritability—the more irritable portions being affected first. This we find is true, for first consciousness is lost, then muscular activity, while the centres governing respiration and circulation are but slightly altered. Were the muscle cells more sensitive to anæsthetics than the brain cells, then the function of the voluntary and of the involuntary muscular systems would fail before the function of the brain, and man would be paralysed while conscious, as in curare poisoning; and since the respiratory and the circulatory muscles would fail, unconsciousness and death would follow the muscular paralysis, and no such state as anæsthesia could be established. It is because of this difference between the muscle cells and the brain cells that anæsthesia and not death is first produced by inhalation anæsthesia.

When ether anæsthesia is continued for four or more hours, these outstanding facts are noted:—

1. Gradually less anæsthetic is required.
2. An increasing period for recovery is required.

3. The brain cells, the liver cells, and the adrenal cells show the same cytologic changes as are seen in exhaustion from other causes.

4. The reserve alkalinity is decreased.

5. The H-ion concentration of the blood is increased.

6. The electric conductivity of the brain is decreased; the electric conductivity of the liver is increased.

7. The temperature of the brain is decreased.

8. The individual is in a state of exhaustion, requiring a period of time for recovery about equal to that required for recovery from an equal degree of exhaustion from other causes.

Nitrous- Oxide-Oxygen.

In nitrous oxide-oxygen anæsthesia, there is apparently an interference with the power of the brain cells to respond to stimulation by increased oxidation. This is shown by the diminished response of the brain to the injection of adrenalin as shown by a slight increase in temperature as compared with the marked increase in temperature—to 0.5° C. and more, in normal animals and in animals under ether anæsthesia. Therefore, the brain cells are able to respond to trauma and other stimuli only in inverse proportion to the depth of the anæsthesia. The brain cells, therefore, are protected against shock. This is demonstrated by the hyperchromatic or normal appearance of the brain cells after prolonged nitrous oxide anæsthesia; and by their normal appearance after shock-producing trauma under nitrous oxide-oxygen anæsthesia as compared with their disintegration after like trauma under ether or chloroform anæsthesia. It is demonstrated also by the fact that the temperature of the brain is progressively decreased by long ether anæsthesia, while it is practically unchanged by even prolonged nitrous oxide-oxygen anæsthesia. These findings are in accord with the conception that the brain is the primary seat of injury from excessive stimulation. The effect of nitrous oxide is somewhat comparable to that of sleep, as our experiments have shown.

Because of the action of nitrous oxide on the intracellular oxidation, its use is fraught with danger unless it is skilfully administered. An animal may be much more quickly killed

with nitrous oxide than with ether. In the hands of a skilled anæsthetist, however, nitrous oxid-oxygen is the inhalation anæsthesia of choice.

Local, Regional or Spinal Anæsthesia.

The immediate effect of spinal anæsthesia is a fall in the blood-pressure. This was demonstrated clinically during the war by Major Gregory Marshall and had been conclusively shown by experiments on animals in our laboratory, the fall in blood-pressure, as shown by Major Marshall, being most severe in patients whose blood is dilute, with a low hæmoglobin content. The menace of spinal anæsthesia appears to bear a direct relation to the degree of instability of circulation. On the other hand, granted a stable circulation, it has been repeatedly demonstrated, both in the laboratory and in the clinic that no amount of trauma upon a part which is physiologically severed from the brain by means of spinal or of a local or regional anæsthesia, can produce any alteration in the brain cells. On the other hand, unless the patient can be guarded from the sights and sounds which accompany a surgical operation, the local and the spinal anæsthetic do not protect him from psychic trauma.

The Anæsthetic Method of Choice for the Bad Risk Patient.

In the light of these laboratory and clinical observations, the problem in the case of the bad risk patient resolves itself into this. How can he be protected against the dangers of the lipoid solvent anæsthetics such as ether or chloroform, against the suboxidation of nitrous oxide-oxygen anæsthesia, against the low blood-pressure of spinal anæsthesia, against the psychic trauma which accompanies local or regional anæsthesia? We have concluded that the solution of these problems lies in a combination of different methods of anæsthesia whereby the safest stage of each may be used to only that degree required to accomplish its purpose.

In bad risk cases spinal anæsthesia is contraindicated because of its effect upon the blood-pressure, but local or regional anæsthesia, however, may be used with safety except

for the psychic factor for the control of which a light degree of a general anæsthetic is required. The lipoid solvent ether, however, must be avoided as well as danger from the sub-oxidation by full nitrous oxide-oxygen anæsthesia. These two dangers are met by using nitrous oxide-oxygen only to the stage of analgesia; and minimizing the psychic factor still further by narcotization with morphin or with bromides in cases in which morphin may be contraindicated. Experiments have shown that in the stage of analgesia, the internal respiration, *i.e.*, the acid-alkali balance of the cells is not impaired; and that by the use of this combination of analgesia, local anæsthesia and narcotics, the bad risk patient may be carried through his operation without any further impairment of his internal respiration.

It may be well to add, however, that in the case of the bad risk patient, the surgeon must bring to bear every other possible aid. The operation must be short and deft and with minimum trauma and should be performed in the patient's room without removing him from his bed, a procedure which with proper organization can be carried out as asceptically as the operation in the operating room.

ANÆSTHETIC APHORISMS.

When anæsthetizing a long series of cases, if the surgeon says that one patient is straining, it is probably your fault; if he says that they are *all* straining, it is probably his—but on no account say so.

Do not use ethylene-oxygen or acetylene-oxygen for anæsthetizing patients on whom diathermy of the tongue is to be performed. The reason will be obvious to those standing at a distance of over 20 feet. To those closer, nothing will be obvious for some time.

Never argue about the colour of a patient. It is well known that some of our eminent surgeons are colour-blind, and have the greatest difficulty in distinguishing between pink and black.

Too many pokes spoil the cornea.

Take care of the airway, and inquests will take care of themselves.

A false tooth in the hand is worth two in the larynx.

—*St. Bartholomew's Hospital Journal*, Aug., 1924.

THE INFLUENCE OF ANÆSTHESIA ON THE RESULTS OF MAJOR ABDOMINAL OPERATIONS.

By Professor Dr. HANS FINSTERER (Vienna.).

IT is with great pleasure that I accept the invitation of the editor of the *British Journal of Anæsthesia* to report my experiences in the anæsthesia of abdominal operations. As a result of 15 years' experience and 2,863 laparotomies performed under local anæsthesia, as well as by making comparisons with the course of cases operated on by other surgeons under general narcosis, I am fully convinced that especially with major abdominal operations the kind of anæsthesia is just as important as is the performance of the operation under reliable asepsis.

It is a fact that after deep general narcosis of a long duration with chloroform, also with ether even in operations where the abdominal cavity is not opened, there may appear severe gastro-intestinal atonies which finally lead to peritonitis and death which latter occurs much more frequently with abdominal operations. Moreover, it is an almost general doctrine that the muscular relaxation necessary for an abdominal operation may be attained only by a deep general narcosis for which purpose, according to the opinion of many surgeons, even ether will not suffice and it will be necessary to use chloroform; therefore for many surgeons the rule holds good to begin every great laparotomy in general narcosis with the *Billroth*-mixture (chloroform 100.0, alcohol 30.0, ether 30.0), or otherwise with a mixture of chloroform and ether, and only after opening the peritoneum and examining the abdominal cavity to perform the proper stomach or intestinal resection in ether narcosis. These surgeons will not abandon chloroform because they are of the opinion that a deep general narcosis with complete muscular relaxation cannot be attained by ether, which is in contradiction with the experiences of other surgeons. On the other hand big quantities of ether

severely injure the lung. Therefore in Austria and also in Germany chloroform is used more or less at the same time when ether is given the preference for the narcosis.

In America chloroform is not used at all, at least not in the Western States where, until recently, ether was the generally applied narcotic, by means of which a sufficiently deep anæsthesia was attained also in major abdominal operations. From my personal interviews during my trip through the United States of America I concluded that the numerous cases of death from pneumonia was the principal reason why they were looking for a less dangerous narcotic. Besides, Crile proved by his very important experimental investigations and by a considerable clinical material, that ether as a lipoid-dissolving drug exerts a detrimental influence on the brain cells, on the liver, the heart, the suprarenal capsules, etc., also that ether more particularly *increases the acidosis of the blood* which represents the cause of the shock and subsequent death. Later on I must refer once more to these exceedingly important facts which Crile reported in his book, "Surgical Shock and the Shockless Operation through Anoci-Association," which work is too little known and appreciated in Austria and Germany.

The so-called cases of *death by narcosis*, viz., such fatalities as occur during the operation and during the narcosis itself, may be easily avoided if an experienced physician, whose chief occupation is to narcotise will direct the narcosis, and if besides contra-indications against a narcosis and also against the operation are observed, viz., that patients with a bad cardiac defect at the stage of decompensation, with severe pulmonary and renal affections, and bad general conditions are excluded from the operation. Such fatalities, however, as occur two or four days later as a sequence of the detrimental influence of the narcotic on the heart, the liver, the suprarenal capsules, etc., may be fewer if the patients are under the hands of an experienced anæsthetist who will reduce the quantity of the narcotic as much as possible, although *such fatalities can never be prevented entirely*. I was never apprehensive of the cases of death during narcosis, but I always dreaded such fatalities as occur two or four days later and are missing in no statistics and are erroneously ascribed

to the severity of the operation. Such cases of death as a sequence of the detrimental secondary effect of the narcosis may be avoided only if for anæsthetising a drug is applied having no bad influence on the organs of the liver, the suprarenal capsule, etc., because it either does not enter the circulation in an effective quantity as is the case with novocaine in local anæsthesia or because it works only by the substitution of oxygen in the blood as is the case with laughing-gas (nitrous-oxide). Hence there exists an important distinction between the *lipoid-dissolving* drugs hitherto used by us as chloroform, ether, and the *means substituting oxygen*, viz., the laughing-gas (nitrous-oxide) and ethylene recently applied in America which acts similar to narcylen, introduced into Germany, since only the former exert a general detrimental effect which we do not find with the latter.

A year ago I reported my experiences on more than 2,400 abdominal operations in a monograph on "Local Anæsthesia Methods, and Results in Abdominal Surgery," which monograph since then was translated into English by Dr. Burke of Buffalo (State of New York), and published by Rebman Co., New York. In this monograph I explained the reasons why in every great abdominal operation local anæsthesia should be applied, either alone or at least as the most effective part of the so-called combined anæsthesia. Thanks to an invitation by the American Society for Surgical Studies, whose president is Dr. Carl Beck, of Chicago, I could demonstrate the different methods of local anæsthesia in major abdominal operations in all States of America, and, on the other hand, I had the opportunity to get acquainted with the great advantages of nitrous-oxide narcosis, especially as a support of local anæsthesia, so that I am now convinced that in all cases where a minutely performed local anæsthesia will not be sufficient for the laparotomy, *the best supporting means of local anæsthesia will be laughing-gas or ethylene.*

The Author's Method of Conductive Anæsthesia.

It is a known fact that the peritoneum of the anterior abdominal wall is the most sensitive, less so the peritoneum of the posterior abdominal wall, hence for opening the abdomen and the abdominal suture the deepest stage of

general narcosis will be required. By means of *exact conductive anæsthesia of the abdominal walls,* where novocaine is injected not only subcutaneously, but also intra-muscularly, into the posterior rectus sheath, it is possible to open the peritoneum without any pain at all. If by injecting novocaine into the peritoneum from the inside care is taken that the entire peritoneum is anæsthetised we may not only insert the retractors without causing any pain, but we may even pull on the same. By the infiltration of the lateral border of the musculus rectus we obtain a *complete muscular relaxation* which is of great advantage for the operation itself. It is exceedingly advantageous if with each abdominal operation an exact conductive anæsthesia of the abdominal walls is performed, because even if later on general narcosis is applied we may spare the greatest part of the narcotic so that also when using ether the quantities are so little (hardly one-fifth of the otherwise necessary quantity) a detrimental general effect is not to be expected. However, it will be of special importance that by an exact conductive anæsthesia of the abdominal walls their tension is overcome which, as we know is not the case with laughing-gas, so that laughing-gas will do as a supporting means for local anæsthesia which fact also Crile confirms in his book.

Mesenterial Anæsthesia.

In order to render painless the operation on the abdominal organs the nerves running along with the vessels in the mesenteries must be blocked off by injecting novocaine-solution into the mesenteries according to certain rules. In 1912 I recommended *mesenterial anæsthesia* for the purpose of gastrectomy, which is fully described in my book on the methods of local anæsthesia.

If the organs are little movable thus requiring a pulling on the mesentery and with it on the peritoneum of the posterior wall in performing the operation, and in order to render the latter painless it will be absolutely necessary to anæsthetise also the peritoneum of the posterior abdominal wall by the injection of novocaine. We can therefore perform a gastrectomy for ulcer absolutely free of any pain by mere mesenterial anæsthesia if the stomach at the same time is

ptotic, while with a small stomach in high position and with a penetrating ulcer also the peritoneum of the posterior abdominal wall must be anæsthetised. In order to stop the sensibility of the posterior abdominal wall we must *block off the rami communicantes* of the thoracic and lumbar nerves by means of novocaine injections. In the epigastric region such rami communicantes are united in the *nervus splanchnicus major and minor*. We may overcome the sensibility of the entire epigastric region by an injection of novocaine into the surrounding of the splanchnic nerves either from the back, according to Kappis, or from the front, according to Braun, after opening the abdominal cavity. If the surgeon cannot make up his mind to perform splanchnic anæsthesia which, if performed from the front, is very easy and without danger according to my own experience and that of Braun, which together refer to more than 1,500 cases, he should at least in every case perform an exact conductive anæsthesia of the abdominal walls and inject novocaine into the mesenteries, which is by no means dangerous, and use laughing-gas temporarily for the painful moments during the mobilisation of the stomach.

For the surgeon it is decidedly more pleasant and time-sparing to perform major operations under deep general narcosis, since one of the most important conditions for operations in local anæsthesia is to operate *delicately and carefully* which is in favour of the healing of the wounds. There are some patients who are afraid of an operation without general narcosis since they cannot believe that such operations can indeed be performed without causing any pain. Yet local anæsthesia should be applied with any abdominal operation since it shows great advantages over general narcosis. We may *considerably increase our indications for the operation without at the same time increasing thereby the mortality*. Owing to the fact that the contra-indications against general narcosis do not come into consideration at all when using local anæsthesia we may perform an absolutely necessary operation with full success, also in cases with serious heart affections, even if the cardiac defect is not compensated, and the same with severe pulmonary diseases which operations would have to be rejected if performed under general narcosis.

The same holds good also for bad general condition and advanced cachexia which I shall go into more fully when discussing the different operations.

Urgent Operations.

With the so-called "urgent" operations on account of acute intestinal obstruction and diffuse peritonitis, the exclusion of general narcosis is of importance for the course of the operation itself. Any general narcosis (also ether narcosis) considerably diminishes the blood-pressure if performed at such a degree as is required for opening the peritoneum, the *blood-pressure* already diminished by the disease *will sink still further.* At the moment of eventration the intra-abdominal pressure on the paralysed abdominal vessels will give way, therefore the blood will replete the paralysed abdominal vessels which must lead to *fatal collapse.* The best anæsthetist cannot prevent such collapse and it is not his fault if the patient, in spite of every precaution with the narcosis, will die at this moment. Up to now it was the standing rule to *avoid any larger eventration* and to content oneself with the performance of an *enterostomia.* If one has to deal with an occlusion of the intestinal lumen by a foreign body, by a carcinoma, etc., hence if there is no strangulation of the intestine, the life of the patient will not be endangered by only doing enterostomia. If, however, there is a strangulation of the mesentery with a gangrene of the intestinal wall (volvulus, internal incarceration under a cord), the patient will die of progressive peritonitis in spite of enterostomy. *Therefore we shall be compelled to establish the cause of intestinal obstruction in each case.* This will be possible if prior to the operation intravenous infusion of physiological salt solution is made with the addition of adrenaline, besides injections of pituitrin, etc., in order to raise the blood-pressure which is diminished owing to the disease, and if a further sinking of the same during the operation caused by general narcosis is excluded; and, finally, if during the eventration the patient will inhale ether by drops as an *excitans,* or if we perform an intravenous ether-narcosis with a *slight* concentration of ether which is even better for raising the blood-pressure.

Up to now among 60 cases of acute intestinal obstruction

and diffuse peritonitis in consequence of perforation of hollow organs (peritonitis in consequence of appendicitis *not* included) I only had a *single case of death during the operation* although I have tried such operation in every case, even if the pulse was not palpable in the radialis and where the extremities were cold and cyanotic. This fatality was a woman, 79 years old, who came in for operation on the fourth day of a complete intestinal obstruction, almost without any pulse, and where a volvulus with gangrene of almost the entire small intestines was found. The patient died after excision of the gangrenous intestines when the two intestinal lumina were sutured into the abdominal walls. In all other cases I could finish the operation and was not obliged to content myself with an enterostomy. The following examples will prove more particularly the range of local anæsthesia.

Thirteen years ago a patient, 25 years old, was admitted to the Hochenegg Clinic suffering from a volvulus of the flexura sigmoidea with a most severe collapse (pulse 160, which was hardly palpable, the extremities were cyanotic and cold) for the purpose of being operated on. A laparotomy was performed under local anæsthesia of the abdominal walls, then the over-distended flexura sigmoidea was slowly evacuated by puncturing when it was possible to get out the enormously distended flexura (which after the resection was holding 12 pints) from under the abdominal walls and to perform the detorsion. For this stage of the operation a short ether-narcosis was applied. The exciting effect of the ether and the simultaneous detorsion improved the pulse in such a manner that after the resection of the gangrenous flexura, the circular intestinal suture could be made. Recovery.

In a man, 27 years old, who was brought into a sanitorium for the purpose of being operated on, on the sixth day of intestinal obstruction, a very busy surgeon who operates only under general narcosis refused to perform any operation at all since he was sure that the patient would die during the operation on account of the bad general condition (pulse 160, hardly palpable, extremities quite cold and cyanotic, the abdomen enormously distended, stercoraceous vomiting). Yet I tried the operation under local anæsthesia, and only after performing the laparotomy on the right side I found the turned and

enormously over-extended flexura sigmoidea. Resection of the gangrenous flexura, sewing in of both intestinal lumina into the abdominal walls; recovery. After further six weeks closure of the anus *præternaturalis* by a renewed resection of the colon and circular suture. Recovery. Since then the patient has gained 60 pounds.

A woman, 71 years old, suffering from a duodenal ulcer for many years came in for operation 15 hours after perforation with a diffuse peritonitis. The pulse was hardly palpable in the radialis and quite irregular. Only after intravenous infusion of physiological saline solution and adrenaline the pulse somewhat improved so that the operation could be attempted. The laparotomy was performed under local anæsthesia with a 0.25 per cent. novocaine solution, ether was administered by drops as an excitant (during the entire operation 10 ccm. of ether). The large perforation opening was sutured, the pylorus ligated with a silk-thread, then the posterior gastroenterostomy was performed and the abdomen washed out with a solution of physiological salt solution. Recovery. The patient has had no trouble whatever since, which is now six years.

Lumbar Anæsthesia.

Lumbar anæsthesia should be avoided on account of the dreaded sinking of blood-pressure in cases of acute intestinal obstruction. Death might be expected during operation if lumbar anæsthesia is performed. The importance of the anæsthesia in urgent operations is realised more and more, particularly in America; Crile, Farr, Skiller and others are in favour of local anæsthesia in such cases.

The results of operation are much improved by the exclusion of deep general narcosis. Fatalities of so-called operative shock occurring within the first 24 hours may be avoided in the same way as the fatalities of heart-collapse if one has not to deal with severe uncompensated cardiac defects. Among 2,863 laparotomies, in which there were 907 stomach-resections and 170 intestinal-resections, *I had no fatality of so-called operative shock* although I performed resection in all cases, no matter how old and cachetic the patients were. In cases of most severe and uncompensated cardiac defects or in cases of

marked anæmia after acute hæmorrhages where no surgeon would ever think of an operation under general narcosis, one might occasionally experience a fatality since the organism cannot stand even the slightest further loss of blood. With acute hæmorrhages and severe anæmias in consequence of carcinoma (hæmoglobin under 15) I observed fatalities within 24 hours. Such cases must be excluded, since no surgeon would operate on them under general narcosis.

The experimental investigations by Schur and Wiesel give a scientific explanation for the fatalities of the so-called surgical shock. These investigations show that with narcosis of long duration the chromaffine system in the adrenals becomes exhausted thereby causing a diminished excretion of adrenaline. These severe *injuries to the adrenals,* due to general narcosis, were confirmed by the investigations of French authors (Delbet, Herrenschmidt and Beauvy). Crile's book, which I warmly recommend, contains several pictures which also show the bad influence of ether on the adrenals. Decrease of adrenaline contained in the blood is the consequence of this injury to the adrenals. Adrenaline, however, is very important for the fact that it balances the increased acidosis of the blood due to the narcosis which, according to Crile, causes the phenomena of shock and fatality.

The *hepatic injuries* occurring after the narcosis and which may finally lead to death under the picture of acute yellow atrophy of the liver, are of special importance. These fatalities are most likely to come about if the liver-cells are already injured by the disease. Therefore those apparently unexplainable fatalities on the 3rd—5th day which occur with operations for acute affection of the abdominal cavity, for affections of the gall-bladder, etc. Herff and Stierlin, twenty years ago, had already referred to such fatalities, and Sprengel ten years ago, on the ground of his own experience, declined the use of chloroform with these operations. The experimental investigations by Widal, Abrami and Hutinal proved that to ether also must be ascribed a similar detrimental influence on the liver-cells as with chloroform. Crile's book as well shows pictures which demonstrate the bad influence of ether on the liver-cells. Therefore Crile's advice must certainly be followed to abstain as much as possible from the use of ether

with such diseases and to apply only local anæsthesia reinforced by laughing-gas. Regarding the latter the results of investigations by Widal and Crile differ from each other. While the former experimentally produced liver defects by laughing-gas Crile could not ascertain such defects in his experiments. Since with the combination of local anæsthesia and nitrous-oxide only little gas is required for a short time one will hardly have to count with any liver defect.

(*To be continued.*)

A CASE OF ACIDOSIS FOLLOWING CHLOROFORM ANÆSTHESIA.

By H. P. Fairlie, M.D.

The following case may be of interest to readers of the *British Journal of Anæsthesia* as a corollary of the one to which I referred in the number for January, 1924.

It is that of a girl of 13 to whom I administered an anæsthetic for acute appendicitis on the evening of October 5th. As she had a slight bronchitis I decided to administer chloroform, and, for this purpose, used the Vernon Harcourt inhaler. The anæsthetic was well taken, and an appendix distended with pus was removed, drainage left in the wound. The immediate progress was good, and, although on the day after operation, the 6th, the patient vomited small quantities of greenish fluid, her general condition gave no cause for anxiety. On the 7th, however, in the late afternoon, the vomit began to assume a brown colour, and became very frequent. A smell of acetone was detected in the patient's breath and she was decidedly drowsy, almost comatose, though restless. Salines containing soda bicarb. and glucose were administered. This condition persisted throughout the 8th until the evening, when there were three loose, watery stools. Omnopon, grain ½, was given and this was followed by cessation of the vomiting, and an improvement in general condition. On the 9th no more vomiting occurred and the acetone smell had almost disappeared. On the 10th her condition remained the same except that slight jaundice was noticed. On the 11th the patient was very well, the bronchitis almost gone, and thereafter she made an uninterrupted recovery. Throughout this attack of acidosis the temperature never rose above normal, the pulse was rapid till the 9th.

The case seemed to be worth reporting as another instance of the dilemma to which I referred in the above quoted paper. In this case I was impaled on the other horn of the dilemma, again fortunately without loss of the patient.

ACETYLENE-OXYGEN ANÆSTHESIA.*

By Dr. AARON GOLDMAN and Dr. JULIUS D. GOLDMAN.

AT the outset we must thank our friend Dr. Hermann Wieland, the author of the first thorough research into acetylene for anæsthesia. It was after over two years' laboratory experiments upon animals, heart muscle, etc., that he published the first report on the "Action of Acetylene" (*Arch. f. Exper. Path. u. Pharm.*, 92 S., 96). His studies were so gratifying, that together with Gauss, in 1923, acetylene-oxygen was used for 500 operations in German hospitals—the anæsthesias lasting from three minutes to three hours, 16 mins.

Acetylene has received an extensive test in Germany during the past year, and for nine months we here have carried out experiments upon white mice and guinea pigs. During that time we have made a careful study of the literature of the subject published since 1920 and of some of the literature published before that year. Our opinion is that acetylene and oxygen form a safe anæsthetic, possessing many advantages and some disadvantages. It will replace ether and chloroform in America more extensively than it has in Germany. It will challenge some of the ground that has been taken by ethylene. We hope that as a result of the presentation of our findings someone will take up the subject in a more thorough and more scientific manner and will take advantage of all that has already been accomplished in Germany.

Conclusions based on experiments with Mice. About a year ago, through the help of Dr. James T. Gwathmey, we commenced experiments upon white mice with ethylene and oxygen and with nitrous-oxide and oxygen. A short time after that the Union Carbide and Carbon Company attached to one of our Gwathmey machines a tank of commercial acetylene, and we commenced to compare the effects of the three gases with and without urethane, paraldehyde, and anesthol.

* Presented before the Eastern Society of Anæsthetists at New York, October 21, 1924.

We owe much to Mr. H. S. Smith and Mr. Critchett of the Union Carbide and Carbon Company. A number of experiments were held in their Long Island laboratories—all of the quantitative and qualitative gas analyses were made there. At the end of about six months we came to the following conclusions:—

(1) Anæsthesia can be maintained with percentages of oxygen much higher than that in the air.

(2) If a proportion of oxygen is given equal to that which, with nitrous-oxide, gives anæsthesia, the life of the animal is quickly endangered; death will come quickly.

(3) With percentages of oxygen equal to or greater than that in the air.—(*a*) Many of the animals in prolonged anæsthesia, say after half an hour, showed signs of danger by gasping. (*b*) Whenever, upon the showing of signs of danger, they were removed into the open air recovery ensued. (*c*) When the proportion of the gases was not changed the gasping generally continued or increased, and death followed. (*d*) In some cases the animals were kept in the container gasping for many minutes and upon removal to the air gasped one, two, or three times, and did not recover.

(4) Symptoms of danger are readily recognized and appear sufficiently before stoppage of breathing for us always to bring the animal into the safety zone, with ease.

(5) The safety margin is much more favourable with commercial acetylene and oxygen than with either ethylene and oxygen, or nitrous-oxide and oxygen.

Purifying the gas. In these experiments the commercial acetylene was passed through the watertight feed which removed some of the acetone in which acetylene is dissolved. Wieland had warned us against the use of impure acetylene. Phosphine and sulphur were the chief impurities. Some time was now spent in an attempt to purify the gas. We finally cut down the impurities to:—

	Before purification.	After purification.
Phosphine	0.002	0.0003
Sulphur	0.008	0.002

by passing the gas through a tower as it left the tank and before it entered the mixing chamber.

The Acetone. The tower also helped to remove a large amount of acetone. This was evident both by the smell of the water in the sight feed and by the analysis of this water. With the use of the tower it appeared that a higher concentration of acetylene was required to give the same anæsthesia. In the fifth report on "Action of Acetylene," Schön and Sliwka call attention to the narcotic properties of acetone vapour. As the tank is emptied, a gradually increasing quantity of acetone escapes with the gas, and it appears probable that the increased narcotising effect, as the tank is being emptied, is thus produced.

Salivation. We took this tower-purified gas in two experiments upon ourselves—oxygen 30 per cent., acetylene 70 per cent. The effects were very similar to those of nitrous-oxide and oxygen and of ethylene and oxygen, except that anæsthesia came more quickly and there was much salivation. We wrote to Wieland referring to the extent of the purification of the gas and to the salivation. His answer is of interest (Aug. 1924): "In the acetylene which I used in later experiments after purifications with copper chloride, in volumes of one hundred litres, there was not a trace of phosphine and sulphur demonstrable. The acetylene (Narcylen-Ingelheim) nowadays used for medical purposes in Germany, has been shown, through examination by the Chemical Technical Imperial Institute, to be absolutely free from the two just mentioned or other poisonous mixtures.

"The salivation which you have observed in the experiments on yourselves I have not noticed in the mouse; but I do remember it in the rabbit. It also occurred in the experiment upon man when—as at the beginning was not of infrequent occurrence—the proper concentration for prompt narcosis was not found.

"With improvement in apparatus these occurrences have become more infrequent. However, it is generally the rule at present to prepare the patient by subcutaneous injection of atropin and scopolamin."

Absolute Purity?

In the above letter emphasis may be placed upon one clause: "In volumes of 100 litres there was not a trace of phosphine or sulphur demonstrable."

We have not been able to obtain a gas in which there is not a trace of phosphine or sulphur. These impurities in volumes smaller than 100 litres are demonstrable. All German literature on the subject of Narcylen speaks of the unpleasant odour. The gas Narcylen is passed over pine flavour (Tannenduft) to hide the unpleasant odour. In our work we have obtained samples of very highly purified acetylene, which appeared to us, had no unpleasant odour, rather ethereal. What the unpleasant odour of "Narcylen" is due to we do not know. In the near future we expect to obtain samples of the German product for analysis.

Exact Calibration? Throughout what we have said so far we spoke of exact percentages of oxygen. Let us state here that at the commencement of our experimentation, by the use of the gas-meter to test out our apparatus, we established certain criteria for oxygen and acetylene percentages. As time went on frequent gas analyses brought to light discrepancies in these criteria. It is only lately that we were able to make changes in the apparatus to feel more reasonably certain of the oxygen percentage figures. Even at present we do not believe our calibrations are exact. Mr. Bagley, a civil engineer of the Union Carbide and Carbon Company, arranged our old Gwathmey apparatus with two manometer attachments communicating with the acetylene and oxygen flow. These flow meters were calibrated and charted. Gas analyses appear to check up these figures and showed certain discrepancies in the comparative sight feed hole determinations upon which we had depended a great deal before that. The apparatus was now rigged up so that the gas was passed through a large trap for purifying the acetylene and for removing a large proportion of the acetone before the gas entered the water sight feed.

We have thus far not determined the amount of the latest purification. Mr. Coltman has, however, assured us that the gas is purer than we have ever before obtained it. To us the

odour appeared less obnoxious than before. We have, though, learned to place little faith in our sense of smell. Those of us who have used ethylene for a long time know that we become more accustomed to the odour with time.

Latest tests—animals and humans. With a flow meter chart before us we tested the apparatus upon an animal and found that we could keep it anæsthetised by running the acetylene between 80 and 60 per cent. Mr. Bagley and Mr. Coltman, being present, one of the authors gave the other the anæsthetic for seven minutes and fifty-three seconds, gradually increasing the oxygen from twenty to forty-five per cent. Marked retching followed. During the anæsthesia the subject maintained a splendid colour throughout. The breathing was regular, machine-like, after the first ten breaths. Rebreathing was used throughout the last five minutes. The next morning, Saturday, October 18, the subject of the evening before became the anæsthetist, and the chemist, Mr. Coltman, the patient. Two teeth were extracted, a flap made, and an area of some rarefaction curetted. Mr. Bagley, stop watch in hand, kept the notes. The anæsthesia was continued for five minutes and fifty seconds, the percentage of oxygen being gradually increased from twenty-five to forty-five per cent. The patient had not eaten since the night before. His first remark as he awoke was: "It took me no minutes to come to." As a matter of fact he expressed these words ten seconds after the anæsthetic was discontinued. There was no vomiting or retching. He telephoned his wife to prepare a substantial meal as he was quite hungry. He looked absolutely normal during the time of the anæsthesia and until he left for the Long Island laboratories. Two days later he reported that he had no after effects, either locally or generally. As we have stated before, our product is not absolutely free from every trace of phosphine and other impurities. Prof. Wieland and C. H. Hechringer Sohn have so frequently warned us against the use of acetylene which is not absolutely pure that we will not recommend this product until we can further purify it.

(To be continued).

THE PERCENTAGE OF ETHER IN BLOOD, MILK, URINE AND THE BREATH DURING SURGICAL NARCOSIS WITH ETHER.

By KARL GRAMEN, M.D.,

Lecturer in Surgery, Alingsas Hospital, Sweden.

A.—EARLIER INVESTIGATIONS—EXPERIMENTS ON ANIMALS ONLY.

Previously published investigations into the percentage of ether and other common narcotics in the organism, deal exclusively with experiments on animals—cats, dogs, guinea-pigs, goats.

The first writer belonging here is Lassaigne (1847). Later come Lallemand, Perrin and Duroy (1860), Frantz (1895), Nicloux (1906—1907), Storm van Leeuwen, Schram, and van der Made (1916), and Le Heux (1918).

We have quantitative analyses of the percentage of ether (and to some extent of chloroform—ethyl chloride and nitrous-oxide) as regards—

1. The Blood.
   (*a*) Both during narcosis in a comparatively late stage from the ceasing of homolateral reflex action under electric stimulus (0.1 per cent. weight) to the suspension of respiration and the action of the heart (0.164 per cent. in weight);
   (*b*) and after narcosis, during the period of elimination.
2. Solid bodily tissue (*e.g.*, while breathing is suspended: blood, 0.142 per cent., brain, 0.156, spinal marrow, 0.131, heart, 0.108, kidneys, 0.105, weight per cent).
3. Transmission in mother's milk (goat).
4. Transmission from mother to fœtus (guinea-pig).

We have no statements touching the percentage of ether in urine and the breath.

Of special interest from a practical surgical point of view are the investigations according to which—contrary to what

is generally assumed—no potentializing takes place in narcosis with ether+chloroform or with ether+magnesium sulphate (Le Heux).

B.—MY OWN INVESTIGATIONS ON MAN DURING CLINICAL NARCOSIS.

Material.

The clinical material consisted of more than 50 patients in the surgical, gynæcologic, or obstetric section.

The investigations were made during the ordinary course of the narcosis without this being in any way influenced in an experimental direction. The problem was to determine the quantity of ether present at the various stages of narcosis, coincident with a certain surgical intrusion (cutaneous incision, etc.), and during the period of elimination.

Quantitative analyses of ether were made—

1. From venous blood both during narcosis and after, throughout the whole period of elimination (411 analyses in all).
2. From urine and breath after the end of the narcosis (150 and 66 analyses respectively).
3. As to transmission of the ether in the mother's milk from suckling women (19 analyses).
4. As to transmission of the ether from the mother's blood to the fœtus's in obstetrical narcosis (38 analyses). (In the last case the blood was taken from the umbilical vein.)
5. As to the ether that is involuntarily inhaled by the narcotizer and other operating assistants (10 analyses).

Classification of the material according to different forms of narcosis.

1. Ordinary ether narcosis, permanent dropping on open mask :—
   - (*a*) Patients with average nourishment and health;
   - (*b*) very corpulent patients;
   - (*c*) noticeably lean and reduced patients;
   - (*d*) alcoholists.
2. With closed and semi-closed methods.
3. Ether+oxygen narcosis.

While the sample of blood was taken, detailed notes were made of the stage of narcosis and of the operation. The course of narcosis is divided, according to the Scandinavian text-books, into five stages, of which Stage III (superficial narcosis) and IV (deep narcosis=no reaction to the surgical trauma), together correspond to " the surgical stage."

Results.

A short summary of the result of about 700 quantitative analyses of the ether.*

1. *Percentage of ether in venous blood.*

In deep narcosis [=surgical stage second stratum] the percentage of ether in the blood, as determined by the average of 67 analyses, *amounts to* 80 *mg. per cent.* These values, however, vary very much.

After narcosis has begun the percentage of ether, with the ordinary ether dropping, rises in about ten minutes to this height, at which it then remains while narcosis lasts, with greater or lesser variations according to the pace of the dropping demanded by the operation.

After the narcosis ends the percentage of ether at first sinks very rapidly, then slower and slower. The curve in question is very regular, resembling a mathematical curve. The fall of the curve in the first few minutes varies considerably, according to the duration of the narcosis. The shorter it is, the steeper is the curve, and *vice versa.* After an average length of narcosis (½—1 hour) the percentage of ether in the blood diminishes during the first fifteen minutes by almost a half. After a very short narcosis the percentage sinks in five minutes to a half, or even to a third.

The length of the period of elimination is as a rule one to two days, determined mainly by the length and profoundness of the narcosis. The age, general health, corpulence, cachexia, etc., of the patients do not appear to influence the blood-curve,

* For a detailed description, record of experiments, and the methodology of the analyses, see the author's " Untersuchungen ueber den Aethergehalt in Blut." Von Karl Gramen, *Acta Chirurgica Scandinavica,* Supplementum I, Stockholm, 1922.

either during or after narcosis, with the possible exception of a longer period of elimination for very corpulent people.

Comparison with the results of previously published experiments on animals.

In our text-books it is still stated, following Nicloux, that 130—140 mg. per cent. of ether in the blood is required for anæsthesia. The primary statements in question are not, however, clearly formulated. Nor do they adapt themselves for a comparison of different causes. The only values suitable for this purpose are those stating the percentage of ether in the blood at the ceasing of homolateral reflex action under electric stimulus, in all 40 analyses with an average of 99 mg. per cent. (Storm van Leeuwen, Le Heux.) Deep narcosis in the clinical sense is, for reasons easily understood, a very elastic conception, since sensibility varies so much in different organs. The electric stimulus employed in the above-named experiments on animals may be said to correspond to the highest degree of irritant to be thought of in surgical operations. The above-mentioned value from experiments on animals, viz., 99 mg. per cent., and mine, 80 mg. per cent., from clinical observations of deep narcosis, may therefore very well be in keeping.

As regards the period of elimination, experiments on animals here yield a result of four hours (Nicloux). This statement, however, is based on a single negative investigation with the application of an inexact method of analysis, and is consequently of little value.

2. *The percentage of ether in urine.*

An exact determination of the percentage of ether in the urine is coupled with difficulties that I have not wholly overcome. The values that were obtained with the method employed (bichromate-sulphuric acid method) in the examination of the urine, are collective values for ether + total acetone expressed as ether. In a number of cases the analysis of total acetone alone was carried out at the same time, so that *it may be assumed that the same concentration of ether probably occurs in blood and urine.* The more or less marked anury

during narcosis, and the difficulties of entirely emptying the urine bladder even with a catheter, are contributory difficulties.

3. *Percentage of ether in the breath.*

The amount of ether eliminated by the breath during the first quarter of an hour after narcosis has ceased is considerable. The average of 15 analyses during the first ten minutes amounts to 27.67 mg., *corresponding to 2 drops of ether per litre of air.* The maximum value was 46.75 mg., corresponding to almost 4 drops per litre of air. The curve in question is markedly irregular during the first half hour, probably owing to irregular respiration, and quite regular later.

4. *Narcosis with ether-oxygen-gas.*

All surgeons appear to be agreed in the opinion that the supply of oxygen-gas during and after ether narcosis is an advantage. Yet we still lack a satisfactory explanation of this fact, viewed from a physiological point of view. My own curves here (five patients) do not differ essentially from the others, with the possible exception of diminished post-narcotic acidosis, which in that case could explain the diminished post-narcotic troubles.

5. *Transmission of the ether into the mother's milk.*

The percentage of ether in the milk is practically the same as in the blood. Several circumstances speak in favour of the suitability of considerably shortening the time for the now usually long interruption in suckling after narcosis (one day). *A few hours after an average length of narcosis the percentage of ether in the milk is so small that in all probability there is no risk in the child taking the breast then.*

6. *Transmission of the ether from the mother's blood to that of the fœtus.*

After four minutes' superficial narcosis ether was noted in the blood of the fœtus. *The concentration of ether which, in ordinary superficial narcosis, in spontaneous release or with light forceps passes into the blood of the fœtus, is about half that of the mother's.* In none of these cases did the fœtus

appear to be influenced by the narcosis. *The longer the narcosis lasts, the more the difference is levelled.* In a Cæsarean section the percentage of ether in the mother and the fœtus was 74 and 55 mg. per cent. respectively (after 175 gr. ether in 37 mins.). In this case the fœtus showed plain signs of narcosis, and could not be induced to cry until after 40 mins. This case warns us in similar cases not to make too energetic attempts at resuscitation.

7. *Transmission of the ether to narcotizer and operating staff.*

In examining the ether that was involuntarily breathed up by the operating staff it was proved, *e.g.*, that the narcotizer after an average length of narcosis eliminated *through the breath in about two minutes a quantity of ether corresponding to one drop*. The possible practical importance of this has not been elucidated, but several circumstances indicate that there is a risk, especially in long-extended work in badly ventilated operating halls.

8. *Influence of the intensity of the narcosis on post-anæsthetic acidosis* (in the signification "percentage of acetone bodies").

Together with the analyses of ether, serial analyses were made of the total acetone and β-oxybutyric acid in the blood and urine of 12 patients. The increase of β-oxybutyric acid in the blood under narcosis was generally small, but in one case the increase was 75 mg. per cent., and the absolute percentage of this acid at the end of the narcosis was 93 mg. per cent., *i.e.*, about three-quarters of the quantity noted in coma diabeticum. This was the only case in 345 observed which revealed clinical symptoms of serious acute acidosis. It was this case too that showed the highest average percentage of ether in the blood during narcosis, 95 mg. per cent. It was, moreover, an unusually profound and troublesome narcosis during a technically extremely difficult operation for resectio ventriculi, 475 gr. ether in 95 mins. The above-mentioned and other observations *definitely indicate that the profundity of the narcosis is an important factor in the formation of β-oxybutyric acid in the blood.*

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THE ALLEGED INCONVENIENCES OF LOCAL ANÆSTHESIA WITH NOVOCAINE

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AN inquest, recently reported to the American Medical Association, attributed to toxic effects of the local anæsthetic, brings into prominence the question of accidents following on local anæsthesia. The question as it concerns novocaine alone has been discussed by some German surgeons. Since events like the above are apt to raise an unjustifiable fear in the minds of medical men, we think it opportune to report a series of researches which we have conducted into the writings of a considerable number of colleagues (124). Before detailing the results of this research we would draw attention to certain pharmacological and physiological data, a knowledge of which is necessary to an understanding of the question. Novocaine (chlorohydrate of amido benzoyl diethyl aminoethanol) is a successor of cocaine and is the least toxic of anæsthetics. It is regarded as the ideal local anæsthetic. It is a white substance in needle-shaped crystals, very soluble in water and alcohol. Neutral solution is turbid in the presence of alkali, clears on addition of bicarbonate of soda. It is not decomposed by boiling. The crystals melt at a temperature of 156°. The solution should be clear and resist decomposition for several months, if kept in well-stoppered bottles. It is best to use freshly-prepared solution. A rosy tint does not constitute a defect, nor a yellowish tint with a light white sediment. A yellow colouration depends on alteration of the adrenaline, which is used in conjunction with novocaine.

The anæsthetic efficiency of novocaine is much enhanced by addition of a few drops of adrenaline (Braun, Läwen) in the ratio of gr. 0,4 per novocaine solution, 1.1 per cent. (Hoffman and Kochmann) of bicarbonate of soda, gr. 0,85 to novocaine solution of 3,50 per cent. (Gros, Schiassi), and lastly of carbolic acid in the ratio of gr. 0,35 per solution of 4 per cent. (Hirsch, Gehse).

The vehicle can be distilled water, but if preferred it can

be physiological isotonic solution. Allen uses a lower concentration of chloride of sodium (0.45 per cent.), Philip a higher (0.9 per cent.); Fischer prefers Ringer's solution. Those quoted use more often a physiological solution with addition of adrenaline. We, while we are in agreement as to the use of a physiological solution, which we regard as convenient if not necessary, are of opinion that adrenaline should be less used, for the following reasons:—

(1) In local anæsthesia (or in infiltration) it is necessary that the liquid should diffuse rapidly and easily into the tissues which is opposed by adrenaline.

(2) By its vaso-constricting action adrenaline, while useful at the time of operation, causes inconvenience by the subsevasodilatation (secondary hæmorrhage).

(3) Adrenaline contributes to the heightened toxic action of substances introduced into the organism.

We prefer consequently novocaine by itself, sterilized and in physiological solution; the concentration should be 0,50 per cent. and the maximum dose not exceeding 100 cc. The toxicity of novocaine is subordinate to the concentration of the solution, to the rapidity of its absorption, and to the site of the injection. Braun has estimated the fatal toxic dose per kilogram in the rabbit at gr. 0.40 (subcutaneous injection); at gr. 0,75 for the dog (subcutaneous injection); at gr. 0,15 for the cat (intravenous injection). Regnier has repeated the experiments of Heinecke and Läwen, obtaining identical results: he has besides injected gr. 0,10 and 0,15 into the lymphatic sac of frogs, controlling the action of the heart, and has demonstrated the harmlessness and the innocuousness of the anæsthetic. Picquand and Dreyfuss, according to Schiassi, have determined for the rabbit gr. 0,50 by endoperitoneal injection. Muroya has provided reference of the paravertebral anæsthesia with novocaine. He finds that the lethal dose for rabbits with subcutaneous injection is 0.35 to 0.39 gr. per kilogram of weight; by the paravertebral route one-sixth of the subcutaneous dose is enough, because absorption is more rapid. Absorption can be limited by injection with gelatine, sodium chlorate and adrenaline. Chevalier fixed the fatal toxic dose at 0.45 gr. for the dog per kilogram of body weight.

For man there are no precise data. There is general agreement on the amount of 1 gr. by means of a ½ to 1 per cent. solution. Chaput gives 1.10 gr., Braun and Härtel 1.25 gr. (equal to 2.5 gr. at ½ per cent.), Kroenig 1.65 gr., Pauchet decided on 1.75 gr., with solution of ½ per cent., 1.25 gr. with solution of 1 per cent., 0.25 gr. with solution of 2 per cent. Axhausen uses 1.7 to 2 gr., Läwen 2.10 gr., Siegal employed 600 cc. of a ½ per cent. solution (equal to 3 grs.), Langmeister regards the maximum dose as 700 cc. of a ½ per cent. solution (equal to 3.5 gr.). As to the question of what dose in concentrated solution has given rise to toxic phenomena (sickness, restlessness, etc.) we have the finding of Liebl of 0.75 gr. in a solution of 10 per cent. (Braun's reference). Poisoning by novocaine is characterised by a period of excitement, tremor, motor mesoretination, paralysis, convulsion, dyspnœa, opisthotonos, and arrest of the respiration and of the heart. Following the classification of Härtel we may sub-divide the inconveniences observed by that author and recorded in the literature as :—

(1) secondary disturbances,
(2) transitory intoxication phenomena,
(3) fatal poisoning.

The secondary disturbances are general as well as local phenomena, as likewise are those of the second group.

A.—Secondary disturbances. General phenomena. These are the symptoms referred to as collapse (sweating, pallor, rapid pulse, thirst, nausea, and actual vomiting; the duration is brief, sometimes extremely brief. Braun has witnessed two cases of collapse in 673 gland operations, with cervical paravertebral anæsthesia: perhaps the anæsthetic reached the cerebral circulation; the two patients, however, recovered with great rapidity. In two cases of twelve and twenty-two years of age Specklin has observed two similar instances of collapse from the beginning of the injection, which lasted for 15 and for 30 minutes respectively. Härtel has observed transitory collapse in an anæsthesia of the Gasserian ganglion, and in a splanchnic case. Bier records one case of collapse in anæsthesia of the trigeminal. Heinecks and Läwen record in several cases pallor, acceleration of pulse and heart spasm, dryness of the fauces, and sweating. Such phenomena

appearing during injection have value as premonitory symptoms. Hering had experience of three cases of shock; he excludes impurity of the solution or too strong concentration of the same as the exciting cause.

Holmgren has recorded grave collapse with slow pulse (50) in an old man after injection of 50 cc. of a ½ per cent. solution of novocaine adrenaline in the ear. Holzwart had four similar cases, which recovered quickly. Knencker has observed a form of collapse with dental anæsthesia, using a solution of 4 per cent. Paul has seen cases of shock with cyanosis. Preisser and Ritter record a grave case of collapse, with arrest of respiration, through injection into the vena cava during a paravertebral cervical anæsthesia. Another grave case of collapse lasting five minutes was noted by Wendling in a similar anæsthesia into a vein. Ciaprini has observed severe headaches after operating for inguinal hernia with local anæsthesia. These are to be referred to the type of operation and the high strength of the solution (4 per cent.).

Local phenomena. These are: œdema, painful infiltration, necrosis, abscess; all are absolutely circumscribed and are to be attributed to faulty method. Œdema of the gums, more or less diffused, has been met by Fischer and Stroke. The cause of this accident, as Cavini has justly observed, is to be found in " impure preparation, a solution long prepared and altered, in faulty technique, and in deficient disinfection of the gums."

Painful infiltration has been observed by Fischer in dental anæsthesia, due to energetic reaction of the muscular tissue and relative obstacle to diffusion of the anæsthetic. He advises therefore that injection be made into the connective and submuscular spaces.

The illustrious German dentist in sepsis of lymphatic œdema thinks that it is to be attributed (*a*) to susceptibility and local reaction in various individuals, (*b*) to non-isotonic solution, (*c*) to too concentrated solution, (*d*) to injection of too hot or too cold solution, (*e*) to injection at too great pressure or rapidity, (*f*) to lesion of the muscular layer.

Gayn and Martins record necrosis from impure solution. Two or three cases of necrosis of the skin had been seen by Pauchet through injection of novocaine into tissues too poorly

nourished and under the effect of adrenaline. Strohe has seen œdema of the gums ending in gangrene. Witzel and Schroeder have had cases of death of the dental pulp. These accidents are not to be referred to novocaine, but to careless method: we may point also to some abscesses observed by Fritzche and Knencke through injection into inflamed gums.

(B) *Symptoms of transitory intoxication.* These are disturbances of brief duration, consisting of: general analgesia, spasm of the trunk, hallucinating delirium, states of hypnosis and of ecstasy, loss of consciousness, disturbances of respiration, cyanosis with small thready pulse, and renal irritation. Total analgesia subsequent to an injection of 5-7 cc. of a 1 per cent. solution with adrenaline has been reported by Mayer and Schuster. Holm has seen contraction of the mouth and face, clonic spasm of limbs and neck, opisthotonos, the whole lasting two hours in a paravertebral anæsthesia of the neck for operation on the throat (10 cc. of a 1 per cent. solution). Epileptiform seizures have been recorded by Liebl, Schepelmann and Schuster in conjunction with similar phenomena of states of somnolence are reported by Läwen, Gros, Schuster and Kast. Simon has witnessed an instance of erotic hypnosis, and Bertram has recorded ecstasy after an injection of 1 cc. of a 2 per cent. solution. Haberer has found delirium with hallucination follow regional splanchnic anæsthesia by the method of Kappis. Wendling saw a case of loss of consciousness after paravertebral anæsthesia of the neck with accidental injection into a vein. There was cyanosis and an asphyxial state but the disturbance passed away in five minutes. Paralysis and transitory paresis (of motor nerves, 24—36 hours), the cause of which is to be found, according to these authorities, in novocaine injected with rapidity, and in undesirable concentration, have been observed by Braun and Williger (paralysis of oculomotor nerve), Kuhnz (paralysis of the abducens), Bunte, Morel, Kron, Partsch, Fritsche, Morlag, Zilkens, and Cavina (facial paralysis). Finally we record three cases of amaurosis, that of Härtel lasting twenty minutes, following interstitial injection of 10 cc. of a ½ per cent. solution, one observed by Jassenetzki-Woino with palpebral œdema, flushing and fever, after bilateral intra-orbital injec-

tion, lasting three days. Certain very grievous inconveniences during trigeminal anæsthesia are not attributable to novocaine, but to infection. Braun has recorded instances of transitory diplopia.

Respiratory disturbances have been associated with anæsthesia of the pleura : dyspnœa and collapse of lung (Capelle), pleurisy, pneumothorax and mediastinal emphysema (Weil and Gundermann), intercostal paralysis (Härtel and Keppler). Cyanosis has been observed in various instances, by Wendling and Paul, and by Holm, limited to the face and lips with small pulse. After-effects following local anæsthesia with novocaine, and attributed to irritation of the kidneys, are recorded by Orth, Flatry, Steizer and Misli. Morian has seen albuminuria to the extent of 1 gr. per litre, with cylindrical hyaline and granular casts, erythrocytes and leucocytes. The disturbance lasted 48 hours.

(c) Fatal poisoning. The most recently recorded case of death is that observed by Eidens (1923). It concerns a man of 52 years, who was injected with 125 cc. of ½ per cent. (adrenaline) for carcinoma of the tongue, suffered severe collapse, followed by death in 36 hours. Autopsy showed the cause of death to be thrombosis of the longitudinal sinus.

Baltzer (1910) observed a fatal case in a young woman of 23 affected with osteitis of the mandible. An injection was made of 3 cc. of a 2 per cent. solution with adrenaline and a tooth was extracted. Immediately after injection the patient suffered from sickness for half an hour. She improved for an hour and a half when suddenly she became giddy. After sickness the condition grew worse and after eight hours death ensued, preceded by cardiac pain and loss of consciousness. Fischer, with whom we agree, attributes the catastrophe to immediate passage into the circulation of the septic osteitis germs.

Kappis (quoted by Härtel, 1920) saw a fatal result follow paravertebral injection of a 1 per cent. solution. The case was that of a woman of 20 years poisoned by corrosive sublimate. There was severe parenchymatous nephritis anuria, and grave general disturbance. With paravertebral anæsthesia one kidney was decapsulated after a quarter of an hour, when the

patient died suddenly. It is possible that by an error of technique the injection was made into the spinal canal, where the substance was found. Apart from any question of intradural injection the extremely critical condition of the patient explains the fatality. Blinmoeller (1922) reports a case of death after mandibular anæsthesia in a man of fifty-eight. A tooth affected with pyorrhœa had been extracted. After forty-eight hours there was great swelling of the soft palate and faucial pillars. There was trismus and a temperature of 38.5 C., for three days, followed by chemosis, meningitis and death. The autopsy showed thrombosis of the cavernous sinus. The author attributed death to the novocaine; the extraction was a perfectly easy one.

Claus saw two fatal cases in connection with operation on the antrum. In one the patient was a young woman into whose nasal cavity was introduced a tampon soaked in a solution of 10 per cent. novocaine with drops of adrenaline. After twenty minutes the tampon was removed to permit of syringing the maxillary sinus. The patient immediately became cyanosed and died of syncope. The second case concerned a woman of thirty-six in whom the nasal cavity was plugged with a tampon soaked in novocaine 10 per cent. solution with adrenaline, and the inferior turbinal was injected with cocaine (10 per cent.). At the autopsy numerous hæmorrhages were found in the cerebral cortex. Claus ascribes these two deaths to novocaine. We believe that too concentrated a solution was employed in a region capable of rapid absorption and the sudden operative interference.

A similar case was observed by Skollern, Sonnenschein and Mayer following the injection of 7 cc. of a 10 per cent. solution for the frontal sinus operation in a woman of 30. The majority of fatalities are connected with operations on the throat (11), owing to the topography of the region, to the compressing action of the infiltrating anæsthetic on the vagus and sympathetic nerves, to the fact that the operation for removal of cervical glands has of itself no light mortality, and to the possibility of the injection entering a vein or the spinal canal. In connection with this event we must remember the proximity of the bulb and its centres and the particular action of novocaine on the respiratory centre (Soupault and Camus).

Research shows the necessity for using, into the paravertebral route, one-sixth of the dose approprite to subcutaneous injection, for the spinal roots are capable of very rapid absorption, even if unilateral injection is employed. (Key.)

Of the eleven fatal cases, two are reported by Brütt with a few cc. of a ½ per cent. solution; two by Hering in similar conditions, two by Holm with 10 cc. of a 1 per cent. solution, one by Key with paravertebral unilateral injection, one by Melchior, one by Mayer, one by Naegeli in which the patient became suddenly unconscious but died three days after the injection, which was 25 cc. of a 1 per cent. solution. Wiemann reports one case in which death ensued directly after injection. The injections were all with adrenaline and poisoning ensued by the paravertebral route.

(To be continued).

BOOK REVIEW.

"ANÆSTHESIA." By James T. Gwathmey, M.D. Published by J. & A. Churchill, London. Price, 25/- net.

In this second edition of "Anæsthesia" Dr. Gwathmey has placed his great work in the very front line of anæsthetic text-books. He has assembled in one volume all that is worth while in the subject, and each section has been treated clearly and intelligently. Chapters on Rebreathing, Local Anæsthesia in Dentistry, Intravenous Anæsthesia, Ethylene Anæsthesia, and others, have each been written by authorities eminent in their own particular field. The History of Anæsthesia is covered extensively. In fact, this is a most delightful chapter. Physiology is equally thoroughly elaborated, and will amply repay one for close study. In fact, there is no branch of anæsthesia which does not receive serious treatment, and the wide field covered reminds us that there is more than sufficient in this new specialty to monopolise any one individual's full time and abilities.

It is pleasing to note that very extensive space is allotted to Local Anæsthesia. It is quite evident that some of our old "reliables" are being hard pressed by comparative new-comers in the field, and while ether, chloroform and nitrous-oxide still hold the place of honour, there is no gainsaying the fact that splanchnic, paravertebral, parasacral, sacral and transacral anæsthesia, and others, are "elbowing" their way into the theatre here and there. It is well for us to meet this advance by learning what there is to be learned, so that we may be in a position to decide the question upon its merits. Gwathmey and his collaborators make this possible.

ACETYLENE ANÆSTHESIA.

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Historical.

As a result of Wöhler's discovery of the preparation of acetylene by the action of water on calcium carbide, it became possible to prepare this gas in large quantities. Further technical elaboration of the method (Moissan) placed its production on a commercial basis. It is, however, only quite recently that the gas has been examined by various investigators from the pharmacological standpoint. The earlier investigations of acetylene (Rosemann,[14] Gréhant[5]) showed that if mixed with air and inspired a state of anæsthesia was produced in experimental animals. This was followed, in many cases, by death, even when the supply of acetylene was cut off. Mosso and Ottolenghi[11] regarded acetylene as a very dangerous poison which brought about death either suddenly, or after several hours if the concentration inspired was low. This held good even if the living animal was removed from the vitiated atmosphere. Such experiences are, however, not borne out in daily life where the gas is often used for trade purposes and where it appears to be a comparatively harmless preparation, and certainly not a powerful poison.

Pharmacology.

It may be worth while to follow up my[22 23] investigations of acetylene, especially as the more important properties of this gas are more clearly demonstrable.

A few years ago I was experimenting with nitrous oxide. My object was to obtain information regarding its mode of action as an anæsthetic. I succeeded in separating this gas pharmacologically from narcotics soluble in lipoids. I showed that nitrous oxide acts as an inert gas in the case of organisms low in the animal scale such as Ascaris, which is relatively unaffected by the withdrawal of oxygen. A similar

action is to be observed with cardiac muscle, *e.g.*, with the isolated frog's heart. Narcotics such as chloroform and ether, however, develop their characteristic action in the latter cases.

Anæsthetic effects with nitrous oxide are obtainable only with organisms which are markedly dependent upon oxygen. This is especially so in highly evolved animals where lack of oxygen shows itself immediately by characteristic signs of the central nervous system. Certain analogies between nitrous-oxide anæsthesia and anoxæmic conditions such as mountain-sickness, air-sickness, and similar experimentally-produced states led me to the assumption that the action of the gas depends upon either disturbed absorption of oxygen or its faulty utilisation by the nerve cell. Nitrogen and hydrogen, also inert gases, never produce a typical anæsthesia but only suffocation. The difference of nitrous-oxide from these two gases I attempted to explain by the one physical property characteristic of the gas : it is about fifty times more soluble in water than the other two gases.

Initially, I did not investigate the nature of the relationship that might exist between a large quantity of inert gas in the tissues and retardation of oxidation processes in the animal body. Instead I attempted to solve the first problem as to whether any such connection existed at all. This I undertook by examining the pharmacological properties of another gas, which, similar to the above, was easily soluble in water and chemically inert under the conditions existing in the animal. A perusal of tables disclosed that of the various easily obtainable gases only one, namely acetylene, answered my requirements.

My earlier trials with unpurified acetylene gave but little encouragement. My results concurred with those of previous investigators; I found that higher concentrations brought about, as a rule, immediately, or after a varying interval of apparent recovery, a fatal end subsequent to a paralytic stage. It was only after taking special care to purify the acetylene employed, particularly in the complete removal of the phosphoretted hydrogen group that it became obvious that the gas was a harmless compound which failed to produce any effect whatever in a low concentration even on prolonged adminis-

tration. I found that if I increased the percentage of acetylene in the atmosphere an anæsthetic state was produced in the animals under observation, the depth of which varied directly with the concentration. I succeeded in demonstrating in white mice, which are, as is well known, very sensitive to ether and chloroform narcosis, that deep anæsthesia could be maintained up to ten hours and that from it the animals recovered within a few minutes after being brought into fresh air, and remained alive afterwards. Acetylene is, therefore, a gas similar to nitrous-oxide from an anæsthetic point of view. The second characteristic negative property of laughing gas is also present, that is inactivity towards anærobic organisms, and such animals are little affected by want of oxygen. Thus I succeeded in keeping ascaris lumbricoides alive and in active movement for twenty-hour hours in an atmosphere of pure acetylene.

There exists, therefore, great similarity between nitrous oxide and acetylene from a pharmacological standpoint. They differ only from a quantitative point of view. Acetylene is considerably more effective, which agrees very well with its greater solubility in water. Whereas nitrous-oxide mixed with an adequate amount of oxygen fails to bring about any anæsthesia whatever on experimental animals unless the mixture be under pressure, acetylene brings about definite anæsthesia even in the presence of large quantities of oxygen. In order, for instance, to anæsthetise white mice into the characteristic lateral or dorsal position they assume during anæsthesia, mixtures of 45 per cent. acetylene with 55 per cent. of oxygen were sufficient in some cases, and in all cases a mixture of 55 per cent. acetylene and 45 per cent. oxygen. Marked difference in the sensitiveness of the various groups of warm-blooded animals appears not to exist, the figures mentioned already apply also in the human. Apparent individual differences in the sensitiveness of white mice towards acetylene have been explained by Sliwka.[20] The period of digestion is of special importance. For instance, animals that have been starved are anæsthetised only by means of a fairly high concentration of acetylene whereas mice half to one hour after feeding (*i.e.*, during the stage of small intestine digestion) are especially sensitive. The

assumption that there exists a connection between the reaction of the blood towards the acid side and a raised sensitiveness towards acetylene has been supported by experiments. An increased sensitiveness was noted also in conditions of definite acidosis, *e.g.*, after administration of ammonium chloride and similarly in pregnancy.

If the percentage of acetylene in inspired air is raised considerably beyond that necessary for the production of anæsthesia, *i.e.*, from 80 per cent. and onwards respiratory disturbances make their appearance as shown by the investigations of Müller and Mallebrein[12] on cats. The number of respiratory acts increase to three or four times the normal and respiration becomes shallow and irregular; this is followed by a decrease and finally, cessation of respiration, frequently preceded by typical convulsions. Recovery usually takes place (in 24 out of 28 of these experiments) provided the acetylene is cut off prior to respiratory paralysis; respiration, however, may be re-established by a small amount of artificial respiration. We learn from this that the toxic action of excessively high concentrations of acetylene manifests itself as a paresis of the respiratory centre after a period of stimulation; the circulatory system is only secondarily, if at all, affected. The excised frog's heart remains entirely indifferent to undiluted acetylene as with any other inert gas; it was even possible to demonstrate that a heart paralysed by CO_2 could be resuscitated in an exactly similar manner by means of acetylene, as is the case with hydrogen. In the rabbit, and frequently also in the human, inspiration of acetylene brings about in the beginning a moderate rise in the blood pressure which, however, gradually sinks to normal without falling below the latter. Similar to the blood pressure, respiration is quite different from that which obtains in ether and chloroform narcosis—further evidence of a different mode of action of this substance. As regards the influence that acetylene exercises on the different organs no observations have been made as yet; but, so far, there is no evidence that the gas has any action on any individual organ excepting of course the central nervous system. Saito[15] has shown that the rhythmical concentration of the isolated uterus of the guinea-pig is not influenced by transfusion of nutrient fluid saturated with

pure acetylene, in contradistinction to the definite effect of chloroform, ether and other similar narcotics soluble in the fatty compounds of the body.

Of special interest is the behaviour of the blood gases. Schoen[17] has estimated the solubility of acetylene in human blood in extensive experiments; thus 1 cc. of blood dissolves .735 cc. of acetylene at 37° C. at a pressure of one atmosphere of the gas. Under similar conditions but at 15° C,. 1,138 cc. The corresponding figures for the solubility of the gas in water are .745 cc. and 1.15 cc. The solubility in blood is, therefore, slightly less. The figures, however, run very closely parallel, evidence of the fact that the absorption of acetylene in blood represents a simple physical solution similar to that of water. Investigations by Schoen and Sliwka[19] in the rabbit and later experiments by Schoen[18] in the human have conclusively shown that the percentage of acetylene absorbed by the blood stream is directly proportional to partial pressure of this gas in the air inspired. This holds good only under the proviso that the composition of the inspired air is constant and that the air and the blood are in equilibrium in respect of their content of acetylene; this is not the case at the beginning of anæsthesia and in the post-anæsthetic stage. In the former case it requires a certain interval until the blood is saturated, corresponding to the partial pressure of acetylene; in the latter, until the concentration of acetylene in the blood has become immeasurably small after interrupting the administration of acetylene. Schoen and Sliwka found a relative saturation in the arterial blood in the rabbit after 17 minutes and complete elimination of acetylene after little more than six minutes. The corresponding experiments in man were carried out with venous blood and hence are not completely comparable with the animal experiments; but they show that within the first twenty minutes saturation of the blood is attained by means of acetylene and that five minutes after ceasing that administration 90 per cent. of the gas has left the body. The elimination of acetylene takes place much more quickly than its absorption, the result of the almost constant though slight hyperpnœa present. We shall see later that for practical purposes the times required for saturation of the blood and elimination of acetylene from the body will be much

less. Blood reaction cannot be estimated electrometrically in the presence of large quantities of acetylene as the hydrogen in the hydrogen electrode is absorbed by the acetylene present. This was shown by Leake and Hertzman.[10] It is only lately that Leake[9] has succeeded in showing colorimetrically that the pH of the blood during an anæsthetic has only a slight tendency to fall, and hence also on this point acetylene compares favourably with chloroform and ether.

Clinical Use of Acetylene.

In the animal experiments carried out the apparently complete absence of risk with moderate concentrations of acetylene even on long continued administration was demonstrated. Experiments carried out on the investigator in December 1920, and February 1921, showed that no unpleasant actions resulted from acetylene anæsthesia. Following these favourable results the practical employment of the pure gas mixed with oxygen was suggested. In the choice of a clinical co-worker I was very fortunate to be able to secure the services of Professor Gauss, who at the time was with me at the University of Freiburg i. Br., and was easily persuaded to share the labours. Together we were able to work out the technique of acetylene anæsthesia on the human and to elaborate the fundamental outlines of the necessary apparatus; all the details, the collection of clinical experiences and variations of mode of administration are the outcome of his untiring labours. I owe special thanks to Messrs. C. H. Boehringer Sohn, Chemical Manufacturers of Nieder-Ingelheim, who gave us invaluable assistance through more than adequate deliveries of carefully purified acetylene (Narky-" Ingelheim ") and the Dräger-works that most willingly acceded to all our wishes and suggestions, and finally designed an excellent apparatus able to cope with all demands made upon it. This apparatus, a description of which appears elsewhere[4 16] serves to supply the patient with a mixture of acetylene and oxygen, the strength and quantity of which is accurately recorded. It is also fitted with a pliable, tightly-fitting mask. Acetylene, as well as that for clinical purposes, especially the purified preparation (narkylene), is supplied in the large familiar steel cylinders in which it is

dissolved under pressure in acetone. In order to remove the latter solvent, which is not exactly necessary but desirable for the purpose, there exists an arrangement for washing the gas within the apparatus. For special purposes, there is finally provision made to add ether to the acetylene-oxygen mixture, or even to administer oxygen and ether only. The patient should, wherever possible, be anæsthetised on an empty stomach; preliminary preparation by means of hypodermic injection of morphia, with or without scopolamine or atropine, is frequently practised to prevent salivation. This preparation may be omitted; many anæsthetists carry it out in each case, others condemn it entirely.

Having determined that the mask is airtight a rapid saturation of the body is attained by administering a mixture of 70 to 80 per cent. of acetylene with 30 to 20 per cent. of oxygen. After a few breaths sensation of pain disappears and in one or at the most five minutes consciousness is lost. The concentration of acetylene is diminished to and continued at 40 to 50 per cent. throughout the operation. According to the state of the patient and the requirements of the operator, higher or lower concentrations may be necessary for a variable period; it is essential, above all, to avoid muscular rigidity, especially of the abdomen, and to obtain this the lowest concentration should be aimed at which maintains anæsthesia (Solbach[21]). If the patient threatens to regain consciousness, which becomes obvious through swallowing movements and retching, this may be prevented by increasing the concentration for a short time. Towards the end of the operation the percentage of acetylene is gradually reduced to about 20 per cent. or less, but one may only interrupt the flow of active acetylene mixture when no further painful or undesirable stimuli can be expected. The reason is that consciousness is regained very quickly after removal of the mask, as a rule after two minutes, after short anæsthesia during the first minute; it is only in patients who have had morphia that recovery takes longer, following the delayed elimination of the gas from the body as a result of the depression of the respiratory centre. The experiences recorded concerning acetylene anæsthesia in man have been fully given in the publications of Gauss and Wieland[4]; Kurtzahn and Teichert,[8]

Schilgen,[16] Philipp,[13] Solbach,[21] Haselhorst,[6] Amiot and Hermet,[1] Gauss[3] as well as Hurler.[7] Here it suffices to summarise the general opinion concerning the method. Special advantages are as follows:

1. Rapid attainment of anæsthesia with or without slight exhilarative effect.

2. The adequate elimination of pain even for the biggest operations which is always constant even without supplementary drugs like morphia, ether, etc.

3. Uninterrupted course of anæsthesia. Fatalities for which the anæsthetic might have been blamed have not occurred up to the moment, and even long-continued anæsthesia is well borne.

Thus Gauss reported at a meeting of scientists and medical men at Innsbruck in September 1924, the case of a woman who was maintained in deep acetylene anæsthesia for four hours and forty-six minutes continuously, during which she was operated upon by house surgeons of little experience; and regained consciousness a few minutes after removal of the mask. Recovery of the patient was uninterrupted.

Asphyxia could only occur with gross carelessness. Circulatory disturbances had not been observed. The rosy complexion of the patient is remarkable; cyanosis occurs only as a result of mechanical interference in respiration, such as falling back of the jaw, etc.

4. Rapid recovery. Vomiting is relatively rare and occurs in 5 to 12 per cent., according to the type of patient and preliminary preparation (morphia), and occurs more frequently prior to the complete awakening of the patient so that it is not remembered. Occasionally a small amount of retching is observed in the moment of awakening. Long-continued vomiting occurs only in isolated cases and is then referable to the administration of morphia or to special sensitiveness towards anæsthetics in general.

5. The subjective sense of comfort after acetylene anæsthesia. Frequently patients will ask for food a quarter to half an hour after recovery. I heard of a patient who smoked a cigarette with delight ten minutes after the termination of a fairly long-continued operative procedure.

6. Absence of serious sequelæ. Circulatory, renal and hepatic involvement have not been described. The number of post-anæsthetic pulmonary complications given by Solbach[21] (one case of pneumonia and two cases of bronchitis per thousand anæsthesias) is too small to ascribe to any connection between the illness and the anæsthetic employed.

7. The wide application of the method even in disease or conditions which preclude general anæsthetics altogether or prohibit one or the other anæsthetic, *e.g.*, extremes of life, cardiac lesions, anæmia, marked cachexia, bronchitis, pulmonary tuberculosis, Graves' disease, and diabetes. In traumatic shock, acetylene anæsthesia has what one might describe as an " analeptic influence."[8]

Disadvantages are as follows:—

1. Inflammability and explosiveness. It must be pointed out with emphasis that acetylene is inflammable and that an acetylene-oxygen mixture is explosive and hence open fires, electro-cautery and electric sparks must not be allowed to come in proximity to the mask. Omission of these precautionary measures led to an accident in the University Clinic for Women at Munich which, it is true, ended in a fortunate manner. Hurler's report of the incident[7] is instructive because it shows that only the inflammability and not its explosiveness is to be feared if our apparatus is employed. The explosion of a small amount of gaseous mixture contained in the mask and in the bag could hardly cause any direct damage. An extension of the explosion from the mask into the air passages of the patient with its consequences, which might be possible, does not occur as this case clearly shows. On the other hand, an extension upwards of the wave of explosion into the cylinder contrary to Hurler's opinion is completely obviated as shown by extensive experiments. Danger from fire, *e.g.*, from the gas flame of sterilisers which may be present in the operating theatre, is not to be feared. This has been shown by independent chemical analyses of the air in poorly ventilated theatres after prolonged operating.

2. Abdominal rigidity. This condition, which is of importance only in laparotomies, is very obvious to operators accustomed to chloroform narcosis. It is undoubtedly true

that such a complete interruption of all the physiological functions, as is obtained in deep chloroform narcosis, is unattainable by means of the acetylene-oxygen mixture. The relaxation of the muscular wall is, in fact, frequently incomplete when using acetylene. But Gauss[3] has shown in a review of laparotomies at his clinic that the percentage of good relaxation is gradually rising as experience is gained with this anæsthetic. Admittedly, the addition in many cases of small amounts of ether is necessary to the mixture. Interruption of nervous impulses in the abdominal muscles by Crile's novocaine-infiltration appears to bring about constantly ample relaxation of the abdomen so that addition of ether becomes unnecessary.

3. Increased hæmorrhage. This has not been observed by all operators but may be explained by the fact that in acetylene anæsthesia the blood pressure does not fall as is the case with ether and especially chloroform, but is, on the contrary, frequently raised. The amount of bleeding, however, has not been found by any operator as a hindrance.

Up to the present this mode has been employed only in general surgical and gynæcological operations. Experiences as regards its suitability for operations on ear, nose and throat, as well as teeth, are wanting as yet. It is only in latter months that a further fruitful field has been opened to acetylene in obstetrics. Haselhorst,[6] and almost simultaneously, Behrendt,[2] reports extraordinarily favourable experiences in normal labours. Here it has been shown that, by the use of quite low concentrations, about 10 per cent., labour pain can be completely eliminated without at the same time losing consciousness, and hence retaining the co-operation of the patient. A diminution of uterine contractions does not occur: on the contrary, these low concentrations appear to stimulate rather than otherwise. In the second stage of labour the concentration may be slightly raised; and only towards its end or where operative interference becomes necessary is the full dose, necessary for complete anæsthesia, employed. Thus also excessive bearing-down and uterine contractions are eliminated. Damage to mother and child has not been observed by either of the authors. In exsanguined patients or such parous women suffering from heart disease there was,

on the contrary, a beneficial influence noted on the circulatory system. The opinion of the mothers is almost without exception very favourable.

On the whole the new method seems to be destined to displace present-day methods of anæsthesia in many fields. Compared with chloroform, ethylchloride and ether, acetylene has the undoubted fundamental advantage of greater safety. The local anæsthetics are not so free from danger as one used to think. Contrasted with local anæsthesia it is, without doubt, of value to the patient to be preserved from the psychical shock by means of general anæsthesia. Comprehensive comparison with other gaseous anæsthetics on man have not been made. Leake and Hertzmann[10] have undertaken such investigations on the dog and their results have been favourable for acetylene. Nitrous-oxide cannot be employed without the disadvantage of anoxæmia and hence is inferior to ethylene. With ethylene anæsthesia the quantity of oxygen administered must, under the circumstances prevailing, be considerably less than that in the atmosphere, which is never the case with acetylene. The possibility of being able to administer a gaseous anæsthetic with a large admixture of oxygen renders acetylene anæsthesia the safest.

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ABSTRACTS OF CURRENT ANÆSTHETIC LITERATURE.

Münchener Medizinische Wochenschrift, 41, 1924, 1432.

An explosion during anæsthesia with acetylene. Dr. KONRAD HURLER.

Between 300—400 operations had been performed in Professor Döderlein's female clinic with this anæsthetic with such satisfactory results, in spite of some disadvantages, that the occurrence of this alarming accident during an abdominal operation necessitated an alteration of their outlook. The patient was lying in the high pelvic position and a cautery was being used in the abdominal cavity: at the moment of its withdrawal a tremendous explosion occurred. Flames were seen in and around the mask and the patient's hair, and her clothes also took fire. Ten seconds after the first explosion a second severe explosion in the mixing bag, accompanied with a loud report and a burst of flames, led to a panic in which the anæsthetic apparatus was knocked over; luckily it fell on to an instrument table so that further disaster was avoided, one of the assistants removed the acetylene cylinder, the burning clothes were extinguished, and peace reigned once more. The patient received considerable burns, but at the time of this report had escaped with her life. Not even the Professor appears to have suffered damage. Hurler states that according to Hollemann a mixture of acetylene with air containing 3.82 per cent. acetylene is explosive. Investigations made by von Sturm show that a minimum concentration of 3 per cent. acetylene is not approximately reached in the operating theatre, and Hurler concludes that the possibility of an explosion is very slight if the cautery, etc., is not used in the immediate neighbourhood of the mask. He explains this accident by supposing that acetylene, being lighter than air, had collected in greater concentration than 3 per cent. in the clothes and towels, where substantial dilution of the gas could not take place.

The chief disadvantages of acetylene are the tendency to severe jaw-spasm and the indifferent muscular relaxation. Advantages are quick induction without excitement, quick return to consciousness, absence of complications, cardiac, pulmonary, renal, absence of nausea or vomiting in 71 per cent. of cases.

Deutsche Medizinische Wochenschrift, 43, 1924, 1475.

Bad results with spinal anæsthesia. E. SCHEPELMANN.

Spinal anæsthesia has been for many years the method of choice for the author for major operations below the umbilicus, and has proved very satisfactory provided that extreme youth and age, arteriosclerosis, severe anæmia and heart weakness are looked upon as contra-indications, owing to the fall of blood pressure, which may be severe. He does not give morphia or scopolamine beforehand; no mention is made of the drug used nor of the dose. Four cases, out of a very large number, had unfavourable sequelæ. Schepelmann does not admit the possibility of failure of technique or of faulty ampoules. The first case was that of a young girl who complained on the day after the operation for hernia of the canal of Nuck, of numbness and dropping of one foot. This persisted for some months, gradually becoming less marked, so that after a year no traces of paralysis existed. An operation for double inguinal hernia in a man was followed by headache and diplopia, the right external rectus being paralysed. After several weeks recovery was complete. The third case was an operation for retroflexion in a hysterical young woman. On her return to the ward she became very noisy and violent, with complete loss of consciousness; three days later she was more quiet but remained drowsy, was incontinent, and was found to have lost the knee-jerks, sensation and muscular power of both legs. At the end of a long illness, during which consciousness returned, all the signs of lumbar myelitis were present: considerable improvement took place in the course of years, but recovery was never complete. A fatal ending from acute meningitis followed extension of a fractured femur; the patient was a weak-minded man aged 32 years, of violent temper and a syphilitic, who had already escaped from hospital before consolidation had taken place and had refractured the bone. As ethyl chloride had proved unsatisfactory on the former occasion, a spinal anæsthetic was given. Death occurred on the fourth day. Schepelmann is inclined to think that a syphilitic meningitis flared up. He thinks now that organic and severe functional disorders of the central nervous system are to be added to his list of contra-indications.

FRANCIS E. SHIPWAY.

Westminster Hospital Reports, Vol. 19, 1924.

Lung complications disclosed post-mortem after surgical anæsthesia. H. PINTO-LEITE.

During the period 1913-22 (inclusive) some 556 cases of a surgical nature were submitted to post-mortem examination at the Westminster Hospital. As it was considered that an analysis of these cases from

the point of view of the anæsthetist might be of interest, statistics have been compiled from the post-mortem records with a view to determining if possible the connection, if any, which might exist between the lung conditions found post-mortem, and the anæsthetic, mixtures or sequences of anæsthetics used in these cases.

As a result of the analysis of the post-mortem examinations the following conclusions were reached :—

1. That ether does not seem to be followed more frequently by lung sequelæ than does chloroform, in fact the figures arrived at point rather in the other direction.

2. That closed methods of giving ether do not lead to worse results than when ether is given by the so-called open method.

3. That in the operations in the series in which the upper abdomen was the site of the abdominal incision, the percentage of cases showing lung sequelæ post-mortem was unexpectedly low.

4. That in operations on the respiratory tract, lung sequelæ were met with very frequently.

5. That factors other than the anæsthetic have to be taken into account when estimating results as to freedom of post-anæsthetic lung sequelæ, such as the experience of the administrator, the condition of the patient prior to operation, the absence or presence of proper preparation before operation, the duration and severity of the operation, etc.

A MEANING ALL ITS OWN.

VISITOR (at doctor's house to his small daughter) : " Is your daddy in, dear? "

SMALL DAUGHTER : " No, he's out, giving an anæsthetic."

VISITOR : " An anæsthetic! That's a big word. What does it mean? "

SMALL DAUGHTER : " It means five guineas, sir."

—*Jl. Am. Med. Assoc.*

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